Recent progress of red laser diodes for display applications

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Laser based displays have gathered much attention, and they are expected to make an alternative huge market to optical disks for visible laser diodes (LDs), because the displays may have a wide color gamut which can express ITU-R BT.2020, low power consumption, and so on. So far, spatial light modulator (SLM) type projectors and laser backlight liquid crystal displays (LCDs) seem promising in markets. Lateral multi-mode LDs, in other words broad area (BA) LDs, are mainly used for the light sources because the displays require the light sources to emit high output power. Blue and Green LDs consist of AlInGaN based material, which offers large energy difference in a conduction band (ΔEc), resulting better characteristics under high temperature. On the other hand, the red one consisted of AlInGaP/GaAs shows worst because of small ΔEc [1]. In this sense, the red LD may be the weakest link of visible laser light source chain. In this paper, we will present the latest development results of Mitsubishi's red LD for display applications.

ΔEc is determined by the band structure of the semiconductor material itself, thus it is hard to modify ΔEc to improve the LD characteristics dependence on temperature. The dependence is a function of the active layer temperature of the LD, indicating what we could do to improve the characteristics is to re-design the geometry of the LD chip and the package in order to reduce the thermal resistance. We already released ML501P73, which has maximum output rating of 1W pulse (duty cycle: 33%) with lasing wavelength around 638 nm [2]. The LD has a BA-LD structure with 40 um stripe width. The LD chip was assembled on an open type ϕ5.6-TO (transistor outline), because ϕ5.6-TO has been widely used for the optical disks, resulting low cost. To improve the characteristics of red LD, a new concept was taken into design of the red LD for displays. The newly developed LD equipped 60 um width triple emitters in a chip and the chip was assembled on ϕ9.0-TO to reduce heat resistance of the LD. The new LD was also designed to lase at 638 nm. The output power versus operating current dependence on the heat sink temperature of ML501P73 and newly developed LD is shown in Fig. 1. ML501P73 has heat resistance of 9.6 K/W, on the other hand that of newly developed one was reduced to be 3.9 K/W. This reduction in heat resistance resulted in great improvement of output power, for example, 1.45 W to 3.85 W at 45°C, approximately 2.7 times. To the best of our knowledge, this newly developed LD shows a world recorded output power in TO base red LDs.

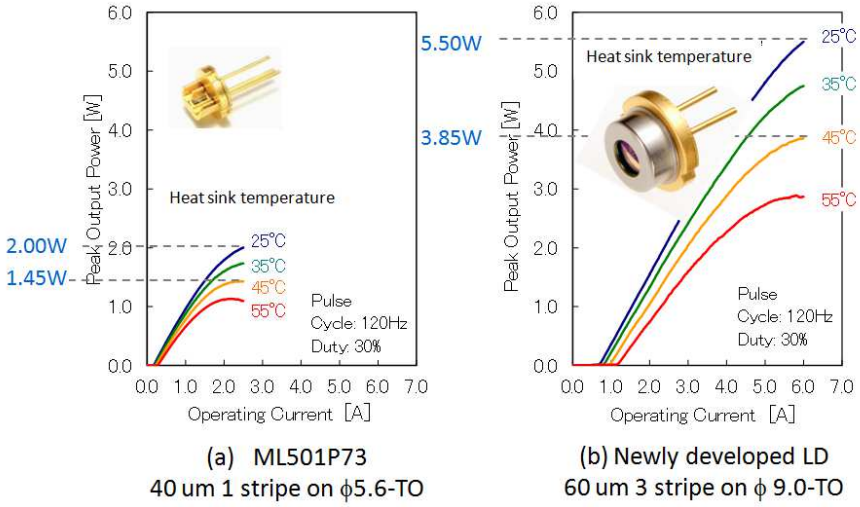

Fig. 1. Output power versus operating current characteristics of ML501P73 and newly developed LD

References

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